How Does a Watershed Effect the Ocean?

Developed by the Channel Islands National Marine Sanctuary, and the UCSB Plumes and Blooms project

Background: The UCSB Plumes and Blooms (PnB) project is an ongoing investigation into the driving mechanisms and impacts of sediment plumes and phytoplankton blooms in the Santa Barbara Channel. Sediment plumes happen when winter rains wash mud, sand, and other debris into the channel via creeks and streams. Phytoplankton blooms occur naturally in the channel on a seasonal basis every spring. The alternating pattern of spring blooms and winter plumes produces a "tree ring" like structure in the channels geologic record. This gives scientist the rare opportunity to examine the channels historical records for important climatic processes such as rainfall and forest fire occurrence over hundreds and thousands of years! The project also matches the physical data collected in the channel to satellite images called seaWifs (www.icess.ucsb.edu/PnB/sw_avhrr.html) to try and understand how the color of ocean water can indicate the physical condition of the water mass.

There are two types of plumes and blooms cruises, the core cruises and the process cruises. **Core cruises** occur at set intervals twice monthly and involve a 7 station transect of the channel. Instruments are deployed at each station to measure a variety of parameters including temperature, depth, salinity, silicone levels, and chlorophyll levels. **Process cruises** on the other hand do not occur at set intervals. These are conducted during or directly after a weather event or other significant occurrence in the channel. The process cruise data helps scientists find out what is going on in the channel during or directly after a storm, whereas the core cruise data is used to look at how the physical properties of the water mass changes over time.

Main Concept: Sediment plumes and Phytoplankton blooms are part of the physical processes that have made the channel what it is today. They can have a profound effect on the marine life of the Santa Barbara Channel. By understanding the dynamics of these processes we can better understand the environment of the channel and the role we play in it as a community.

Objectives: Students will understand the causes of sediment plumes that enter the Santa Barbara Channel and how the physical make-up of these plumes can effect the marine environment. They will use online data sets to look at the water profile of the channel. This includes Chlorophyll A concentrations, Salinity, and Lithogenic Silicone content. Using these graphs they will see how the channel environment changes from near shore to deep water, from season to season, and from year to year. The students will also learn about sediment deposition on the sea floor and its usefulness as an indicator of past weather patterns.

Materials

Necessary

1. Geographic local map that shows creeks and streets (teacher and student copies)
2. Markers, Colored pencils, or Crayons
3. Internet access – goto: http://www.cinms.nos.noaa.gov/home.htm and print the activity sheets.

Optional

1. A large, clear container, or a small aquarium.
2. A bucket of sand, dirt, or potting soil.
3. An egg crate or box that is about the same height as the aquarium.
4. Rice
5. Dye (2-3 colors)

Preparation time: __ minutes

Lesson time: One to two class periods

Management and Safety Considerations: Have student work at the computers in groups.

Procedure:

1. Class Discussion

Plume Discussion

- Ask the students to think about what happens when it rains in the winter. Talk about the flow of water in the watershed and where the water ends up (creeks the ocean).

- Direct the discussion toward water content and what materials might get mixed in with the water on its way down to the ocean. These materials can be soil from the area, fertilizers from the farms, pollution from industrial centers, or trash from State St. Use local map here to identify the 3 main creeks in Santa Barbara that drain into the ocean (Arroyo Burro, Mission, and Sycamore).

- Discuss how creeks and streams are the sources of sediment plumes in the ocean Talk about the winter rains causing plumes and the seasonallity of the process.

Bloom discussion

- Use the seasonality of plumes to segue into Phytoplankton blooms and their seasonal occurrence (spring/fall).

- Point out that, like land based plants, marine plants also have a spring bloom period.

- Discuss what happens to these plumes and blooms after they have run their course. I.e. The plumes settle out of the water column onto the sea floor forming a layer of sediment. The blooms live out go through their life cycle and then settle onto the sea floor forming a layer of plant material in the sedimentary record. (This is how the tree ring like structure of the sedimentary record is formed)

2. Optional Demonstration – can be performed by students or teacher

- Fill aquarium or other large clear container half way with water.
- Place a box or egg crate next to it on a table. Make sure that whatever you use is about the same height as your container
- Take your disposable bake pan or similar container. Cut out one side and fill with soil
- Make sure water will flow easily from your pan to your container
- Pour water into pan forming a small creek that should be rich in sediment.
- Watch sediment plume enter the aquarium. Point out the fact that it settles on the bottom of the tank
- Sprinkle your colored rice on the surface of the water, this is your phytoplankton bloom
- Watch phytoplankton settle on bottom of aquarium
- Do this several times
- Note the layers that form on the bottom

This demonstrates how a sediment plume forms, where it goes, and how it is deposited on the sea floor

2. PnB Project discussion

Introduce the PnB research project to the students

For comprehensive information on-line, go to: www.icess.ucsb.edu/PnB/PnB.html.

Make sure they understand the goals of the project and the usefulness of the data being collected.

Goal: "To understand the potential impacts of current storm runoff in the ocean, such as possible changes in light conditions for subsurface plants and animals [plankton], the spread of terrestrial sediments and possibly human related pollution." - Leal Mertes, UCSB scientist.

Uses: For UCSB ocean color scientists, the alternating patterns of brown sediment plumes and green algae blooms provide an excellent field laboratory for understanding and modeling the color of the sea.
The data can also give Insight into local weather patterns and forest fire occurrences over hundreds of thousands of years and increase our understanding of how coastal communities like Santa Barbara impact marine environments.

3. Internet activity

- Go to http://cinms.nos.noaa.gov
- Have the students find the project clean water activity link in the education section of our website
- There the students will find a summery of the PnB project and the links that will get them started on the activity sheet.
- They will look at discreet data sets from the PnB cruises that are posted on the site.
- The fist data set gives a good example of a spring bloom and the important features of the data will be highlighted
- The next set of data will represent sediment plume conditions and non-plume conditions. This will give the students in idea of what a sediment plume does to the water column and strengthen their understanding of plume causes.
- In the final data set students will look at the 1998 el Nino/ la Nina storm season and see what characterizes both events by constructing a graph of ocean temperature and salinity.

Closure:

- Activity sheets
- Have students watch creeks and look for plumes this winter.

Assessment: Internet Worksheets

Key Words:

Sediment – Particles of matter that enter the water cycle. They are produced by the action of weathering and erosion
Sediment Plume – A cloud of sediment that occurs when heavy rains or floods wash large amounts of sediment into the ocean. Visible from the air, apparent in satellite images and CTD data
Phytoplankton – Microscopic marine plants that live in the upper layer of the world's oceans and float freely in the water column.
Zooplankton – Microscopic marine animals that live in the worlds oceans.
Plankton – A general term for the entire community of microscopic free-floating organisms, including phytoplankton, zooplankton, and a host of other marine organisms. Plankton serves as the primary food source for most marine ecosystems. Many animals like the blue whale feed entirely on planktonic organisms.
Algae Bloom – A bloom, or rapid growth, of phytoplankton in the upper layers of the ocean, often due to an influx of nutrients, such as a sediment plume or seasonal upwelling.
CTD – (Conductivity, Temperature, Depth) Common name referring to a scientific instrument that records Ocean salinity, temperature, and depth. This instrument can also record a host of other parameters such as nutrient levels and chlorophyll concentrations.
Core Cruise – One of the regular BI-monthly research cruises conducted by the R/V Ballena. The cruise involves a transect of seven sample stations in the S.B. Channel beginning at S.B. harbor and continuing across the channel to San Miguel Island.
Process Cruise – A cruise that is conducted during a significant event in the channel such as a winter storm or a period of heavy rain. These usually take samples at the mouth of Ventura Harbor.
Lithogenic Silicone – Silicone that originates from terrestrial sources of rock and soil.
Biogenic Silicone – Silicone that has its origins in the shell structures of living organisms.

Additional Internet Resources

Seawif images - www.icess.ucsb.edu/PnB/sw_avhrr.html

PCW home page - www.co.santa-barbara.ca.us/project_cleanwater/
Plumes and Blooms home page - www.icess.ucsb.edu/PnB/
Clean Water Action Plan - www.cleanwater.gov
CINMS home page - www.cinms.nos.noaa.gov
PCW curriculum page - www.cinms.nos.noaa.gov/pcwcurric.stm

Correlation of Activity to 6th grade science content Standards:

Shaping the Earth's Surface – 2: b-d
Ecology – 5: b,e
Investigation and Experimentation – 7: b,f,g,h

The following were incorporated:

Geography, Physics, Chemistry, Environmental Science, Computer Science